



ARTIFICIAL INTELLIGENCE AND ECOLOGY: STRONGER TOGETHER

Many of today's artificial intelligence (AI) systems loosely mimic the human brain. But Cary Institute scientists Barbara Han, Shannon LaDeau, and Kathleen Weathers are looking to ecology to inspire the AI of tomorrow. With support from Cary's donor-backed Science Innovation Funds and the National Science Foundation, they are exploring what this new frontier could look like.

In a paper in *Proceedings of the National Academy of Sciences*, they have outlined how ecology and AI can transform each other. Ecological principles could galvanize more powerful, resilient, and

socially responsible AI. In return, those evolved AIs would be better equipped to help solve complex ecological challenges such as disease outbreaks, degrading water quality, and loss of biodiversity.

Ecologists are already using artificial intelligence to search for patterns in large data sets and to improve predictions about complex processes. Han, for example, leverages AI to infer when, where, and how new viruses might spill over from animals into humans.

However, there are many more possibilities for applying AI in ecology, such as in finding missing

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FROM OUR PRESIDENT



Dear Friends,

This fall, at my annual State of the Institute address to Cary staff, I summarized our 'state' with a few words: *imperative*, *vibrant*, *innovative*, and *demanding*.

Cary science is *imperative* to answering big societal questions, and solving big societal problems. These include predicting and preventing disease outbreaks, reducing the risk of catastrophic wildfires, getting a global view of freshwater, understanding and safeguarding forest carbon sinks, guiding resilient regeneration of tropical forests, and informing sustainable cities — to name a few.

The Institute is *vibrant*. We recently hired four new core scientists, an increase of 25%, and we have 10 early-career postdoctoral researchers to complement them. We work in an energy-efficient, solar-driven headquarters filled with modern

convening spaces that have expanded our ability to collaborate.

Our research efforts are dynamic, and evolving. We continue to *innovate* our long-term projects, among them our 35+ years of studying the ecological dimensions of Lyme disease, our 20 years of leadership guiding the Global Lake Ecological Observatory Network, and our programs exploring the sustainability of urban systems. New undertakings are expanding our breadth. These include a collaboration to enhance fire resilience in the Western US, a suite of projects aimed at understanding carbon sequestration in the tropics (critical to climate change), and new initiatives on rivers and lakes.

This work — and the scale of our research endeavor — is *demanding* of our time, our focus, and of funds to drive the research. We are expanding our donor base to include new friends, new foundations, and new government agencies. With dynamism comes demands, and our staff are pushing new boundaries.

Thank you all for your support, your passion, and your devotion to Cary Institute. You are critical to our success.

Joshua R. Ginsberg, PhD

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links in complex systems, and generating new hypotheses.

"Compared to other statistical models, AI can sift through vast amounts of data and help us discover patterns and reveal connections that we may not have thought were important," said LaDeau.

Inspired by ecological systems, a more robust AI might include feedback loops and redundant pathways.

Ecology, meanwhile, could help to make AI systems more flexible. Mode collapse, for example, occurs when a system stops generating a diverse range of outcomes, and instead gets stuck on a limited set of very similar outputs. "By better understanding why mode collapse does or doesn't happen in natural systems, we may learn how to make it not happen in AI," said IBM Research's Kush Varshney.

Inspired by ecological systems, a more robust AI might include feedback loops and redundant pathways. These flexibility upgrades could contribute to a more 'general intelligence' for AIs, enabling reasoning and connection-making beyond the specific data that the algorithm was trained on.

Ecology-inspired AIs would then be even better equipped to model and predict natural resilience,

so advancements in both fields would be reciprocal and coevolving.

Because artificial intelligence is good at incorporating information that's not based on numbers — Indigenous knowledge, for example — the researchers hope it could help to decolonize ecology and correct AI's biases.

"Artificial intelligence models are built on existing data," said Weathers. "When those data have gaps — when they do not include, for example, information from undersampled regions of the world, or from underrepresented groups, or from traditional ways of knowing — the resulting models will be unrepresentative and/or biased, and they can perpetuate injustices. Thus, we need to vastly expand and diversify data."

Achieving convergence between AI and ecology research will require building bridges between these two siloed disciplines, which currently operate with different vocabularies, funding sources, and scientific cultures.

Following the paper published last year, the researchers are now working to organize a conference that would bring together experts in AI and ecology to build those bridges.

"We're confident it will spark a lot of unique conversations and innovative outcomes," said Han.

RESEARCH EXPERIENCES INFORM MANAGEMENT IN THE CATSKILLS



In the Catskill Science Collaborative Research Fellowship Program, undergraduate and graduate students work alongside academic mentors to answer research questions posed by natural resource managers working in New York's Catskill Mountain region.

This year's research included:

- Assessing how hiking and bushwhacking impact nesting montane birds
- Surveying populations and habitats of the imperiled wood turtle
- Mapping non-native plants along hiking trails

Learn more at caryinstitute.org/csc



Costa Boutsikaris

STUDY FINDS WIDESPREAD CARBON STORAGE DECLINES IN WESTERN US FORESTS — BUT ALSO INFORMS LOCALLY TAILORED SOLUTIONS

Many strategies for limiting global warming rely on maintaining and increasing the amount of carbon locked in forests and their soils. But a new study confirms widespread doubts about the potential for most forests in the Western US to help curb climate change.

Published in *Earth's Future*, the paper analyzed carbon storage trends — and the main factors shaping those trends — across the American West from 2005 to 2019. Led by Jazlynn Hall, a forest

and landscape ecologist at Cary Institute, the team found that throughout most of the region, climate change and fires may be causing forests to hold less carbon, not more.

“These challenges have the potential to undermine our ability to mitigate climate change using Western forests as natural climate solutions,” Hall cautioned. Fortunately, the study can also inform locally tailored solutions to help prevent or slow down carbon loss in some areas.

IDENTIFYING WAYS TO IMPROVE SATELLITE-BASED SMOKE MEASUREMENTS



As wildfires grow more frequent and severe, their smoke is having far-reaching consequences for human health and ecosystems. Satellites can help measure the thickness of smoke plumes and predict where they're moving next, so people can anticipate and reduce their exposure. But how reliable are satellite data? Ecosystem scientist Kathleen Weathers and her colleagues set out to investigate.

“For satellite data to be most useful, we have to compare them to ground-based measurements,” explained Weathers. “Then we build relationships (algorithms) to relate what's sensed remotely and the real conditions on the ground.”

Using data from the US Forest Service, Hall and colleagues estimated the amount of carbon amassed in living and dead trees across the West, and how this was changing over time and in different types of forests. Machine learning was used to understand which factors — including climate, wildfire, topography, and human activities such as logging or landowner decisions — were most likely driving carbon storage in each region.

The scientists found that carbon stored in living trees declined across much of the Western US between 2005 and 2019. In almost all regions of the West, climate (precipitation, temperature, and air moisture) was the first or second most important driver of live carbon patterns. Fire was the first or second most important driver in two-thirds of the regions.

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Bucking the trend, the Pacific Northwest had some of the only areas where carbon storage increased during the study period. The increases seemed to be largely driven by forests regrowing after changes in logging practices.

“The Pacific Northwest has seen large-scale efforts to reduce harvesting in old-growth forests and

expand protected lands,” said Hall. “So, some of the regrowth may be permanent. It offers a glimmer of hope that we can change things.”

When the researchers began the study, data was only available up until 2019. The analysis did not include the record-shattering wildfire years of 2020 and 2021, and may underestimate carbon loss trends.

While the findings largely rule out increased carbon storage in Western US forests as a climate solution, the paper offers a baseline for monitoring and stewarding these forests. It provides a framework that can help to inform site-specific strategies for reducing carbon loss and strengthening resilience.

“This information could serve as the foundation for forest management strategies to maximize carbon storage where we can,” said Cary forest ecologist and study co-author Winslow Hansen, “and to avoid catastrophic emissions of carbon elsewhere.”

Hansen leads a large research program called the Western Fire and Forest Resilience Collaborative, to inform new ways to live sustainably with fire. The Collaborative will use the baseline established in this study to track how forest carbon is changing over the next five to 10 years and how different fire-management strategies impact carbon storage trends.

Weathers co-authored a recent study that tested the effectiveness of a commonly used satellite smoke detection algorithm. Under different smoke conditions, they evaluated how well the algorithm translated smoke density measurements from a satellite-based sensor to match ground-based data.

They found that the algorithm performed well overall, especially during medium and heavy smoke events. However, it underestimated smoke density when it was mixed with dust, and it overestimated smoke levels above barren land. These findings raise concerns about the algorithm’s future effectiveness, since atmospheric dust and barren land are on the rise due to climate change and land development.

“Our study identifies where refinements need to be made to the algorithm,” said Weathers. “We need these measurements to be as accurate as possible, to estimate risk and health impacts for the people and ecosystems downwind.”

**You can be a part of making
this research possible.**

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BULLETIN BOARD

Opportunities, announcements, and events

Richard S. Ostfeld
Member
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Congratulations to Rick on his election to NAS. Election to the Academy is one of science's highest honors.

Welcoming Tara and Amy to the Cary team



Tara Stewart Merrill
Aquatic Disease Ecologist



Amy Zanne
Ecologist and Evolutionary Biologist

Student Spotlight



Mahamuda Tasmi
Mid-Hudson Young Environmental Scientists

"During the program, working alongside a diverse group of researchers from various fields in ecosystem studies, I discovered that collaboration is the true catalyst for innovation. I realized that each person's unique perspective contributed to breakthroughs we couldn't have achieved alone.

The intersection of ideas, perspectives, and expertise taught me not only about science but about the power of teamwork, where learning from each other is as crucial as the discoveries we seek."

UPCOMING

Scientific Seminars
Thursdays @ 11am
Join us virtually for the latest in ecosystem science from leading academics.

caryinstitute.org/events

TEACHER WORKSHOPS

Professional Development Opportunities
Oct 24: Food, Soil, and Climate Change
Nov 12: Inquiry in the Woods

caryinstitute.org/workshops

VIDEO

Snakes in the Catskills: A Primer
A 101 on snakes, including species you are likely to encounter in the Catskills and greater Hudson Valley.

caryinstitute.org/lecture-videos

Ecofocus is published by Cary Institute of Ecosystem Studies, an independent nonprofit center for environmental research. Since 1983, our scientists have been investigating the complex interactions that govern the natural world and the impacts of climate change on these systems. Our findings lead to more effective management and policy actions and increased environmental literacy. Staff are global experts in the ecology of: cities, disease, forests, and freshwater.

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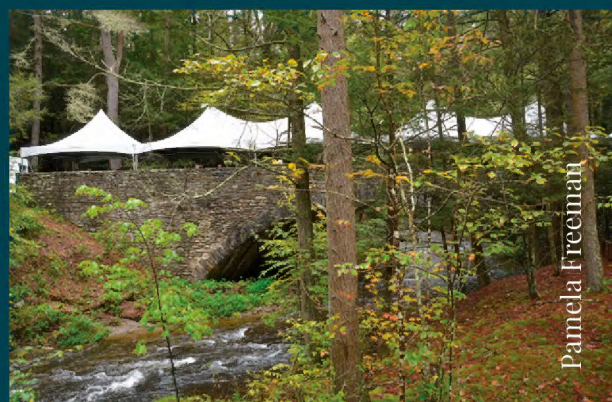
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OUR THANKS

THANK YOU FOR SUPPORTING FALL LUNCH ON THE BRIDGE

September gave us perfect weather for our Fall Lunch on the Bridge. Dining near our peaceful Fern Glen, with the creek rushing below and colorful leaves emerging on the trees above, donors heard from Cary's Peter Groffman on the future of winter in our area. Across the Northeast, winters are warming faster than any other season. In New York, for example, winters have warmed three times faster than summers. Yet people are adapting in surprisingly effective ways.

Co-chairs Perrin Berkey, Farran Tozer Brown, Elissa Kramer and Jay Newman, Elizabeth Farran Tozer, and Helen and Michiel van der Voort brought together a generous host committee and the largest-ever group of underwriters and guests to support long-term climate change science.



We also thank our sponsors: Orvis Sandanona, RSVP by B, Shady Knoll Orchards and Distillery LLC, and Tamarack Preserve, Ltd.

Mark your calendars for the next Lunch on the Bridge on Sunday, September 21, 2025.

A fruitful partnership with the MILLBROOK GARDEN CLUB



"Millbrook Garden Club and Cary Institute have enjoyed a wonderful, collaborative relationship that stretches back to Cary's founding. We have partnered on research projects, lectures, and walks, and our members have been active volunteers. We've gotten to know Cary's scientists and their work. As the club's current president, I'm looking forward to cosponsoring lectures to promote sound environmental practices — in our own backyards and beyond."

- Patricia Rowell



Thanks to our Friends

We want to express our gratitude to Community Foundations of the Hudson Valley and their fund holders. Their generous support has helped to fund ongoing tick-borne disease research, and a social-ecology tour of Poughkeepsie led by Steward Pickett and two partner organizations, Scenic Hudson and The Art Effect. Donors also helped 19 students from Poughkeepsie City School District attend Cary's Eco-Discovery Summer Camp in 2024, and funded field trips to Cary throughout the school year.

With special thanks to:

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Deacon Bill Mennenga Fund
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If you'd like more information or to join the Mary Flagler Cary Legacy Society, contact Nicole at 845-677-7600 x177 or bakern@caryinstitute.org



IMPROVE YOUR SOIL HEALTH THIS FALL

Don't rake and bag leaves. Mulch them.

The nutrients and organic matter in recycled leaves will make soil more fertile, improve soil structure, and can help reduce weeds.

- Mulch leaves with a lawnmower instead of raking and bagging them.
- Add excess mulched leaves to garden beds, around shrubs, or in natural areas.

CARY BIORETS INSPIRES INNOVATIVE SCIENCE CURRICULA



BIORETS teachers experiment with a thermal camera while wading through Wappinger Creek.

For six weeks this summer, nine high school teachers learned what it's like to be a scientist.

These teachers formed the inaugural cohort of Cary's BIORETS program (Research Experiences for Teachers Sites in Biological Sciences), in which educators design and conduct real scientific investigations, then create

curricula to bring authentic research experiences into their classrooms. Cary's three-year program is funded by the National Science Foundation and led by a team of Cary scientists and educators.

Participants worked with Cary scientists on one of three ecological research projects. One group studied how gaps in the forest canopy affect plant productivity. Another investigated the effects of native versus introduced plant debris on mosquito egg-laying. A third group compared soil health in urban versus natural areas.

With continued support from BIORETS, the teachers have now begun shepherding their students through the same process of making observations, asking questions,

designing an experiment, and collecting and analyzing data. The projects look different in each classroom, depending on school resources and student needs. But each teacher's new curriculum emphasizes curiosity and critical thinking — vital skills for the next generation of scientists.

Kristie Wikane, a science teacher at Brookwood Secure Center in Columbia County, said she finds herself constantly asking questions about the data she and her teammates collected. "I hope I can bring that curiosity with me back to the classroom and model for my students — to make observations about the world around them, to ask questions, and try to understand," she said.

